Lithotripsy and Related Techniques for Gallstone Treatment

Adapted from the Proceedings of The Third International Symposium on Biliary Lithotripsy, Munich, Germany, September 13–15, 1990.

Gustav Paumgartner, M.D.  
Tilman Sauerbruch, M.D.  
Michael Sackmann, M.D.  
Department of Medicine II  
Klinikum Grosshadern  
University of Munich  
Munich, Germany

H. Joachim Burhenne, M.D.  
Department of Radiology  
University of British Columbia  
Vancouver General Hospital  
Vancouver, British Columbia
Includes bibliographical references and index.
ISBN 0-8151-6624-9
1. Gallstones—Treatment. 2. Ultrasonic lithotripsy.
I. Paumgartner, G. (Gustav) II. Sauerbruch, Tilman
III. Sackmann, Michael
IV. Burhenne, H. Joachim (Hans Joachim), 1925-
2. Lithotripsy—methods. W1
755 L776]
RD547.L57 1991- 91-22617
617.5’56—dc20 CIP
DNLM/DLC
for Library of Congress
CONTENTS

Preface xiii

SECTION I: BASIC ASPECTS OF SHOCK WAVE LITHOTRIPSY

1 / Influence of Output Setting on Acoustic Field of a Shock Wave Lithotriptor 1
   by A.J. Coleman, M.J. Choi, and J.E. Saunders

2 / In Vitro Fragmentation of Gallstones 7
   by T. Sauerbruch, M. Neubrand, and H. Lobentanzer

3 / In Vitro Fragmentation of Gallstones: A Comparison of Three Different Shock Wave Principles 15
   by H.Th. Schneider, R. Ott, P. Janowitz, W. Swobodnik, H. Neuhaus, and Ch. Ell

4 / Analysis of Shock Wave Destruction of Stones by High-Speed Films and Microscopy 17
   by W. Sass, M. Bräunlich, M. Hayler, E. Matura, W. Folberth, S. Kettermann, J. Seifert

5 / Effect of Shock Waves on Gallstones and Materials 27
   by M. Delius and S. Gambihler

SECTION II: SHOCK WAVE TREATMENT OF GALLBLADDER STONES

6 / Gallbladder Lithotripsy: Evaluation of Clinical Results 35
   by G. Paumgartner

7 / Electromagnetic Cholecystolithotripsy 39
   by H.J. Barhemne, J.S. Fache, B. Rawat, and S.H. Lee

8 / Piezoceramic Lithotripsy: Clinical Results 43
   by Ch. Ell, H.Th. Schneider, J. Benninger, and R. Braun

9 / Electrohydraulic Lithotripsy of Radiolucent Gallbladder Calculi 49
   by M. Sackmann

10 / Targeting and Fragmentation 59
    by W.E. Torres and B.R. Baumgartner

11 / Analgesia for Biliary Lithotripsy 69
# Contents

12 / Piezoelectric Lithotripsy for Gallstones: Results of the First Hundred Patients Treated in Dublin 73  
by A. Darzi, W.A. Tanner, F.B.V. Keane

13 / Influence of Shock Wave Source on the Effects of Biliary Lithotripsy 81  
by M. Staritz, A. Große, and A. Rainbow

14 / Biliary Pain After Extracorporeal Shock Wave Lithotripsy: Effect of Ursodeoxycholic Acid and Stone Fragments 87  
by R.W. Summers, J. Wilkie, J.W. Maher, and T. Dean

15 / Contribution of Ursodeoxycholic Acid to Extracorporeal Shock Wave Lithotripsy of Gallbladder Stones 93  
by L.J. Schoenfield

16 / Gallstone Lithotripsy With or Without Bile Acid Therapy 97  
by A. Darzi, W.A. Tanner, and F.B.V. Keane

17 / Are Bile Salts Necessary With Gallstone Lithotripsy? An Interim Report 103  
by B. Ross, J.P. Nicholl, B.T. Williams, and A.G. Johnson

18 / Dissolution Therapy Is Necessary After Lithotripsy of Gallbladder Stones by Shock Waves 109  
by V. Kordac, J. Benes, J. Chmel, M. Kaláb, and C. Stuka

19 / Early Results of Combined Electrohydraulic Shock Wave Lithotripsy and Oral Litholytic Therapy of Gallbladder Stones at the University of Iowa 113  

20 / Rapid Dissolution of Gallstone Fragments After High Doses of the Combination of Ursodeoxycholic Acid and Chenodeoxycholic Acid Plus Early Shock Wave Retreatment: A Comparison With Chenodeoxycholic Acid 119  
by M. Uribe, J.M. Sánchez, B. Dávila, N. Méndez, A. Merikanski, and F. Bosques

### SECTION III: INTERVENTIONAL TECHNIQUES FOR GALLBLADDER STONES

21 / Interventional Gallbladder Procedures 125  
by E. vanSonnenberg

22 / Organic Solvents for Contact Dissolution of Cholesterol Gallstones 129  

23 / Results of Stone Dissolution by Methyl-tert-Butyl Ether 137  
by J.L. Thistle, B.T. Petersen, C.E. Bender, and A.J. LeRoy

24 / Combination of Extracorporeal Shock Wave Lithotripsy and Dissolution of Gallbladder Stones by Methyl-tert-Butyl Ether 143  

25 / Direct Contact Treatment of Gallbladder Stones: Retrograde Access to the Gallbladder 147  
by E.Ch. Foerster and W. Domschke

26 / Rotary Gallstone Lithotripsy: Follow-up in 19 Patients 155  
by F.J. Miller, R.L. Gordon, and C. Cope

27 / Laser Lithotripsy of Gallstones 159  
by F.W. Schildberg
Contents

28 / Single-Step Technique for Percutaneous Transhepatic Cholangioscopy 163
by H. von Sanden, W. Schmitt, W. Wegerle, and R. Ottenjann

29 / Current Role of Percutaneous Cholecystolithotomy 171
by M.J. Kellett, R.C.G. Russell, M.G. Vaughan, and J.E.A. Wickham

30 / Fragmentation and Percutaneous Removal of Gallbladder Stones 175
by G.R. Wittich, D. Lucas, K. Terasaki, R. McKenzie, E. Lang, and R. Walter

31 / Laparoscopic Treatment of Gallbladder Stones: The Place of Intracorporeal Lithotripsy 179
by J. Perissat, D. Collet, R. Belliard, and E. Magne

32 / Results of Laparoscopic Cholecystotomy 183
by B. Mentges, G. Bueß, A. Melzer, D. Schäfer, and H.D. Becker

33 / Issues and Controversies in Percutaneous Cholecystostomy 191
by E. van Sonnenberg

SECTION IV: STONE IMAGING

34 / Biliary Extracorporeal Shock Wave Lithotripsy: Gallbladder Clearance, Gravitation, Pseudorecurrence, and the Ultrasonographer 195
by L. Greiner

35 / Ultrasound Imaging of the Gallstone Interior: Fact or Artifact? An In Vitro Study 199
by L. Greiner, C. Jakobett, and S. Rebensburg

36 / Ultrasonic Reflex Transmission Imaging Improves Stone Localization and Characterization for Biliary Lithotripsy 205
by K.W. Marich, P.S. Green, J.F. Jensen, A. Stein, and J.W. Pell

37 / High-Frequency Signal Analysis From Gallbladder Stones 211
by W. Swobodnik and K. Kuhn

38 / Comparison of Sonography and Oral Cholecystography in Assessing “Gallbladder Function”: Implications for Imaging Strategies in Patient Selection for Nonsurgical Therapy of Gallstones 213

39 / Assessment of Gallstone Characteristics: The Role of Computed Tomography 217
by R.L. Baron

40 / Computed Tomographic Imaging of Gallstones: What Does It Really Add? 223
by J.T. Ferrucci

SECTION V: STONE RECURRENTCE

41 / Cholesterol Nucleation Time: A Potentially Valuable Parameter for the Prediction of Gallstone Recurrence After Successful Dissolution Therapy 229
by D. Jüngst, T. Lang, and G. Paumgartner

42 / Bile Composition in Early Recurrence of Cholesterol Gallstones 231

43 / Gallstone Recurrence: Frequency, Prevention, and Treatment 235
### Contents

<table>
<thead>
<tr>
<th>Page</th>
<th>Title</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>45</td>
<td>Management of Recurrent Gallstones</td>
<td>T.C. Northfield, M.L. Petroni, and R.P. Jazrawi</td>
</tr>
</tbody>
</table>

#### SECTION VI: BILE DUCT STONES

<table>
<thead>
<tr>
<th>Page</th>
<th>Title</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>46</td>
<td>Extracorporeal Shock Wave Lithotripsy of Bile Duct Stones</td>
<td>T. Sauerbruch</td>
</tr>
<tr>
<td>47</td>
<td>Extracorporeal Shock Wave Lithotripsy in Oriental Cholangiolithiasis</td>
<td>R. Heinrich, A. Schreckenberg, Kyung Sik Cho, Sung Gyu Lee, and Pyung Chul Min</td>
</tr>
</tbody>
</table>

#### SECTION VII: OUTLOOK

<table>
<thead>
<tr>
<th>Page</th>
<th>Title</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>49</td>
<td>Future of Nonsurgical Treatment of Gallbladder Stones</td>
<td>L.J. Schoenfield and J.W. Marks</td>
</tr>
<tr>
<td>50</td>
<td>Future of Surgical Gallstone Therapy</td>
<td>R.A. Malt</td>
</tr>
</tbody>
</table>

Index 275
Previous studies suggest that at least 30% to 50% of patients with complete gallstone dissolution by oral bile acid therapy will develop recurrent stones over a 3- to 5-year period when bile acid treatment is withdrawn.\(^5\)\(^6\) Villanova et al.\(^9\) have demonstrated that patients who had multiple gallstones seem to be at greater risk of recurrence after successful stone dissolution than those who originally had solitary stones.

Abnormally rapid nucleation of cholesterol from supersaturated gallbladder bile is of key importance in primary gallstone formation and might therefore be a major determinant of gallstone recurrence.\(^3\)\(^6\)\(^7\)

It seemed possible that different cholesterol nucleation times or nucleation-promoting activity in the gallbladder bile of patients with multiple stones as compared with those with solitary stones might be responsible for the different rates of stone recurrence.

This is supported by earlier observations of Gollish et al.,\(^1\) who reported a shortened nucleation time in all patients with multiple gallbladder stones while half of their patients with solitary stones (four of eight patients) needed more than 4 days to develop cholesterol crystals. More recently, van Erpecum et al.\(^8\) also found rapid nucleation in bile from patients with multiple gallstones but normal nucleation in most gallbladder bile from patients with a single stone.

Groen et al.\(^2\) have isolated, by concanavalin A–sepharose chromatography of gallbladder bile, a glucose/mannose-containing, 130 kilodalton (kD) glycoprotein with strong cholesterol nucleation-promoting activity in model bile. The activity was found in the majority of gallbladder bile investigated, and high nucleation-promoting activity titers were observed in bile from patients with multiple cholesterol stones. The activity titer in bile was not correlated to the total protein content, cholesterol saturation index, and total lipid concentration. The data of Groen et al.\(^2\) are of particular interest and the relationship between the 130 kD glycoprotein and the pathogenesis of multiple cholesterol gallstones seems to be evident.

We have recently compared cholesterol nucleation times in the gallbladder bile of 59 patients with solitary and 42 patients with multiple gallstones.\(^4\) A clear separation was observed between two groups, one with pigment and mixed and the other with cholesterol stones (Fig 41–1). The results of the median cholesterol nucleation time in the gallbladder bile of these patients are illustrated (Fig 41–1). Long nucleation times exceeding 21 days were usually observed in bile from patients with pigment or
mixed stones, while abnormal nucleation was seen mostly in the bile of patients with cholesterol stones. However, nucleation times were significantly longer in bile from solitary than in bile from multiple cholesterol stone carriers. Only 1 of 32 patients with multiple stones as compared with 10 of 54 patients with a single stone had a normal nucleation time (>4 days). Furthermore, over a wide range of cutoff levels for cholesterol nucleation times the percentage of patients with abnormal nucleation in their gallbladder bile was consistently higher in patients with multiple than in patients with solitary stones. At a cutoff level of 4 days abnormal nucleation in gallbladder bile occurred in 80% of patients with solitary and in about 95% of patients with multiple stones. This is far above the known rate of stone recurrence in those patients.

Rapid nucleation of cholesterol in gallbladder bile may predispose to gallstone recurrence in patients with cholesterol gallstones. The value of cholesterol nucleation times in the prediction of gallstone recurrence could be proved by follow-up of patients with successful stone dissolution in whom sampling of gallbladder bile prior to therapy has been possible.

Acknowledgment

We thank Benedikta Zündt for her excellent technical assistance and her help in preparation of the manuscript.

REFERENCES